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Smiths Detection

Distributed nanocomposite sensor arrays for immediate detection of chemical threats.

Saskia Feast, Ph.D.

Safeguarding your future

Transportation Security • Military • Facilities Security

Smiths Detection
How did we get here?

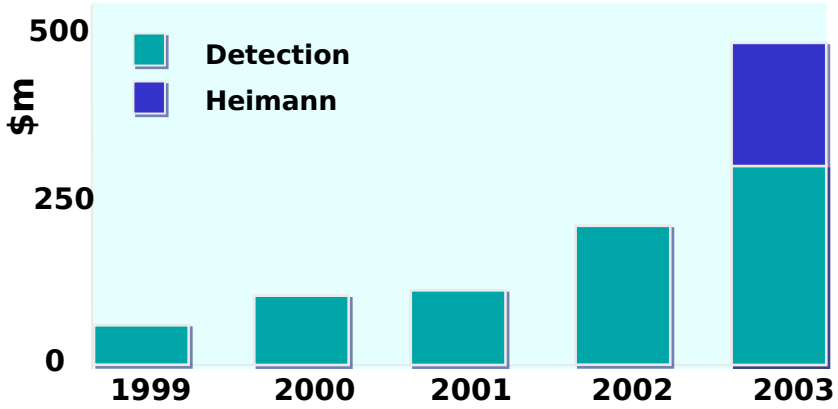
Trace detection
Detecting very small traces of substances including

- Chemical Warfare Agents
- Biological Warfare Agents
- Explosives
- Toxic Industrial Chemicals
- Narcotics

X-ray
Smiths Heimann X-ray imaging systems to identify

- Contraband
- Weapons
- Explosives
- Narcotics

Smiths Detection has been built up through a series of acquisitions and an aggressive drive for organic growth



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What is our strategy?
Continued Evolution of Detection

6 year development

	Oct 1997	Aug 1999	Jun 2001	Dec 2002	Jan 2004	May 2004
	Graseby Dynamics	**ETG**	**Barringer**	**Heiman n**	**Cyrano Sciences**	**SensIR**
Markets	Military	First responders	Airports	International, Commercial		DoD Fed Govt Hazmat
Products	Chemical sensors	Biological sensors	Explosives, narcotics sensors	X-ray	Mini low power chem detectors	FTIR

Agenda

- Brief Company Overview
- Hypothetical Operational Scenarios
- Technology Overview
  - Nanocomposite sensor array
  - Data analysis
- Products in development
  - Individual chemical detectors (I.e. Personal Badge)
  - Distributed Networks (I.e. Unattended Low Level Ground Sensors)
- Sensor Performance
  - Sensitivity, stability, interferents, response time
- Conclusion

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Hypothetical Operational Scenarios : Wearable badge

Wear over MOPP

Not expecting attack
Wear to detect

Post incident
Wear at perimeter

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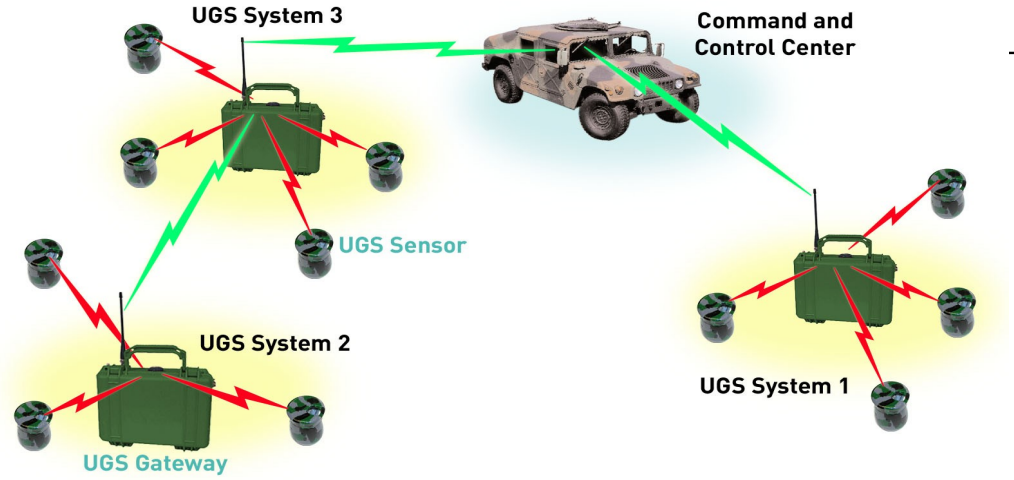
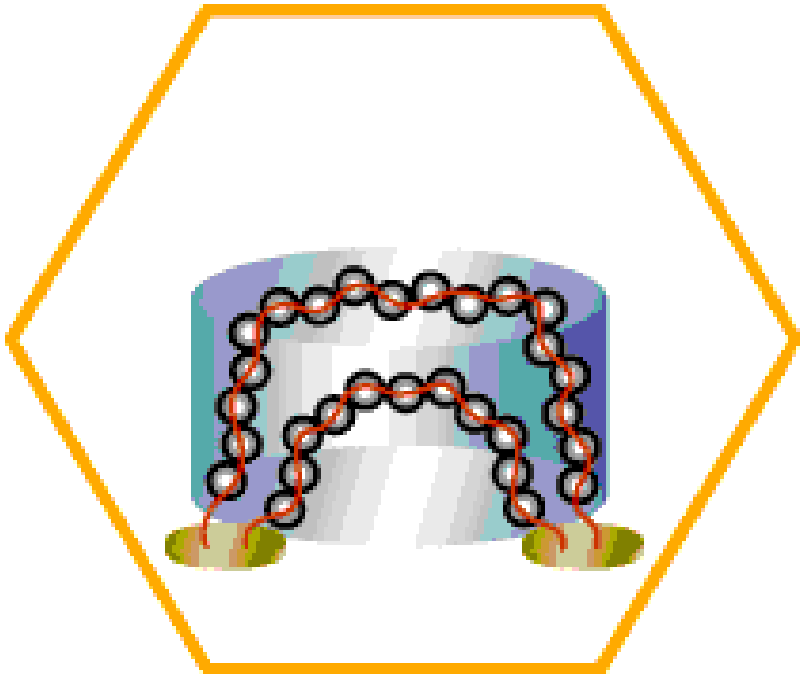
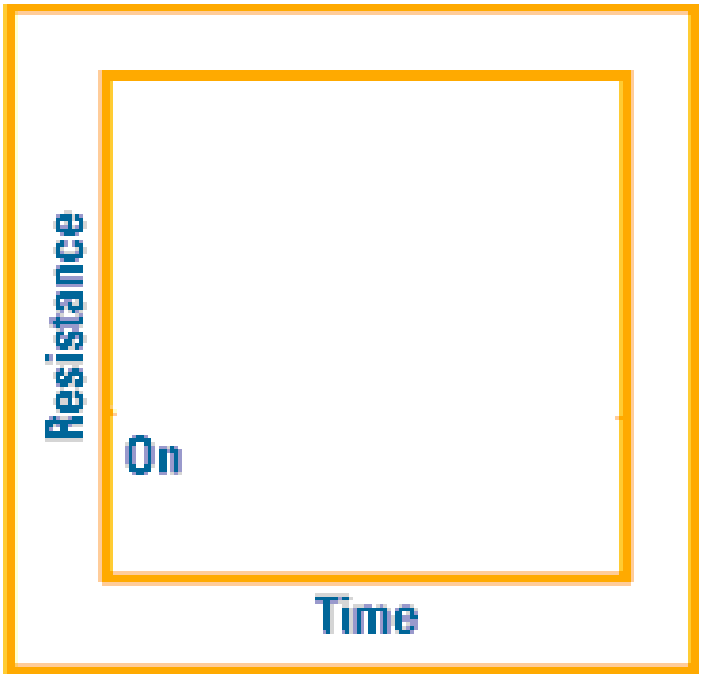
Hypothetical Scenarios: Distributed Sensor Networks

Scenario	Function of UGS
Forward deployment	Throw or shoot out the sensors to ensure area is safe
Backward deployment	Area has been secured, leave network of sensors to ensure no chemical change behind the troops
Area is contaminate	Deploy to see if area remains contaminated.



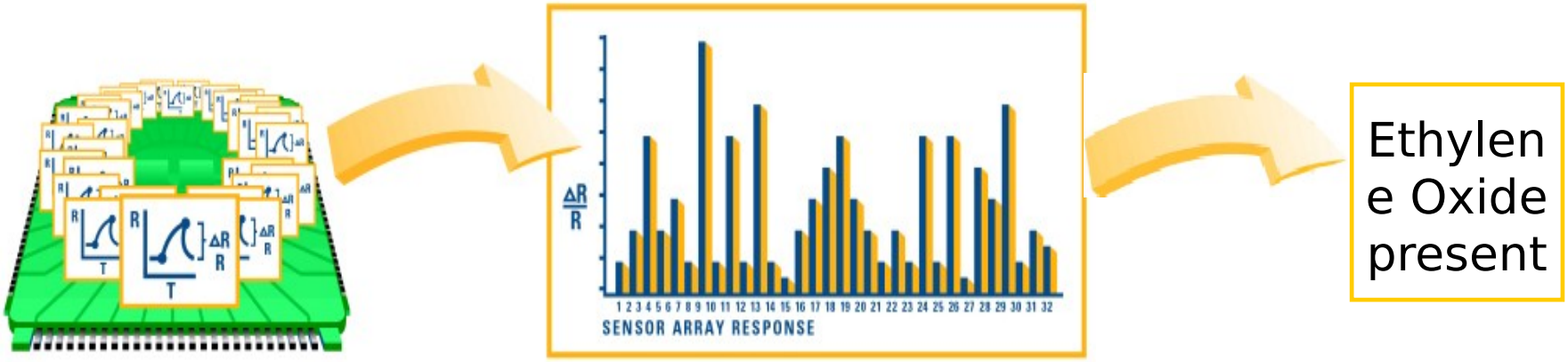
Technology – Nanocomposite Arrays





- Sensitive to chemical agents, toxic industrial chemicals, volatile organic compounds
- Stable to wide range of environmental conditions

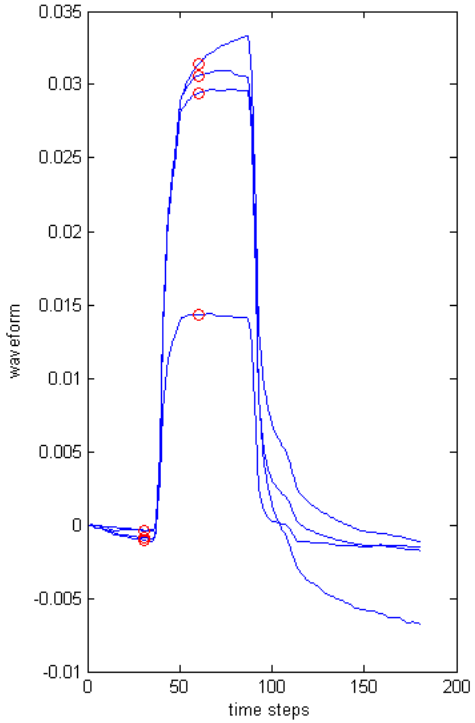
Technology Overview – Pattern Matching

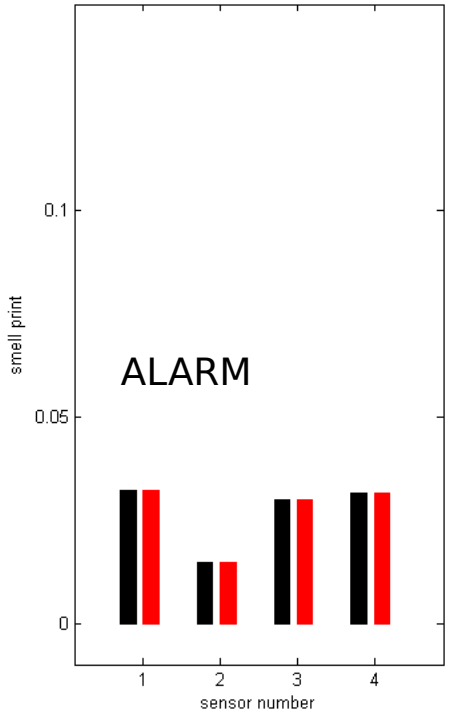


- Using pattern matching algorithms, the data is converted into a unique response pattern and an identification is made.
- Algorithms used include: KNN, PCA, CDA, and SVM
- Algorithms are invisible to the user

Smith's ChemDetection Software

- **Real Time Pattern Recognition enables faster system response time**





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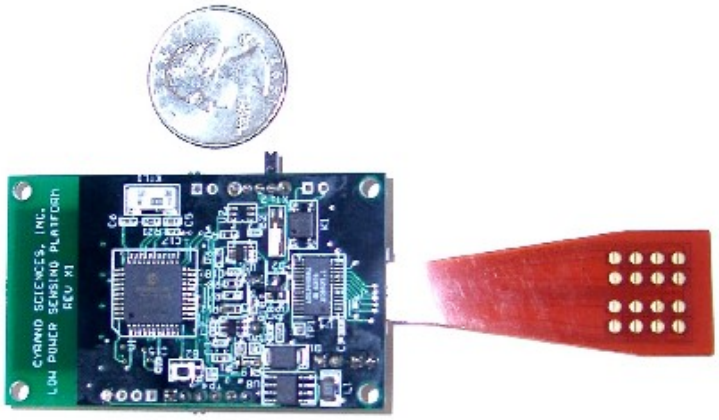
Chem Alert™ Devices

Low cost chemical sensors with optional short-range wireless capability (<300 feet), intended to provide chemical detectors across a number of applications.

Key applications:

- Personal Chemical Badges
- Unattended Ground Sensors
- Temporary or permanent networks



Properties:

- Small
- Simple to use
- Low cost
- Low power
- Upgradeable

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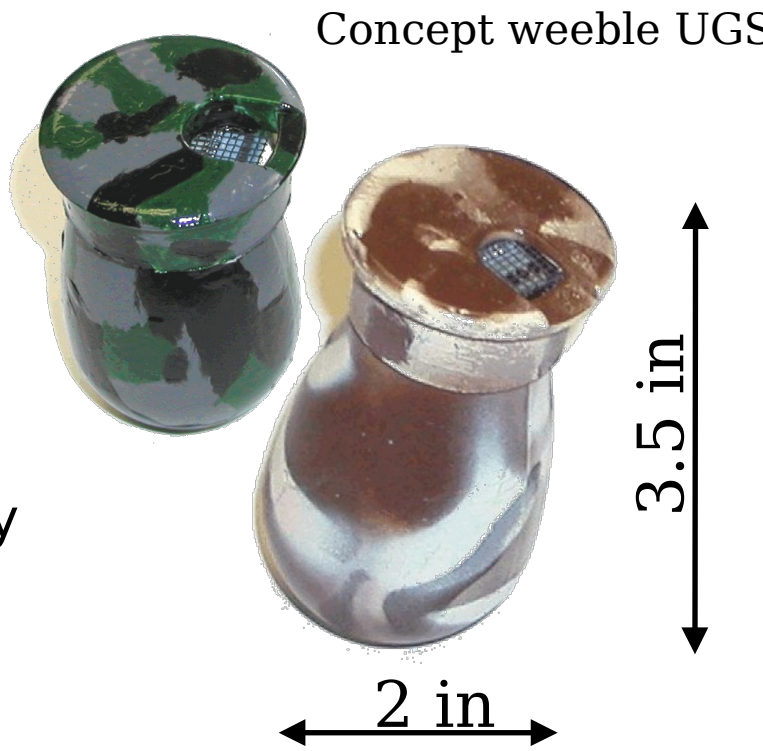
Key Applications- ChemAlert™ for Individual Protection

- Wearable Individual Protection
  - Detects & notifies wearer of exposure to chemical threat
  - Low cost, low power, highly effective detection capabilities to CWAs and TICs
  - Quick detection allows wearer to don protective gear
  - Continuously monitoring
  - Data logging
  - Minimal maintenance

Concept of wearable badge

Key Applications – ChemAlert for Disposable Sensors

- Unattended ground sensors
  - Area monitoring
  - Locate and identify chemical threats
  - Integration of low cost, low power chemical sensors into existing UGS
  - Advanced algorithms to analyze all UGS data for coherent display of complex information
  - Upgradeable for new threats



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Live Agent Test Results

- **Sensitivity**
  - 5 Cyranose units correctly alarmed to GB and HD at 10 and 40 ºC, 50%RH
  - Nanocomposite arrays have detection limits comparable to JSOR requirements

- **Interferents**
  - All 5 Cyranose units correctly alarmed to GB and HD in the presence of interferents: AFFF, diesel, bleach, antifreeze, ammonia, vinegar, floor wax, Windex, Spray 9 cleaner
  - The overall accuracy was about 90% for 193 tests.

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Sensitivity- TICs

TIC Vapor	IDLH (ppm)	NCA sensitivity?
Chlorine	10	✓
Hydrogen Chloride	50	✓
Hydrogen Fluoride	30	✓
Phosgene	2	✓
Ammonia	300	✓
Ethylene Oxide	800	✓
Sulfur dioxide	100	✓
Hydrogen cyanide	50	✓

IDLH- is Immediately Dangerous to Life or Health

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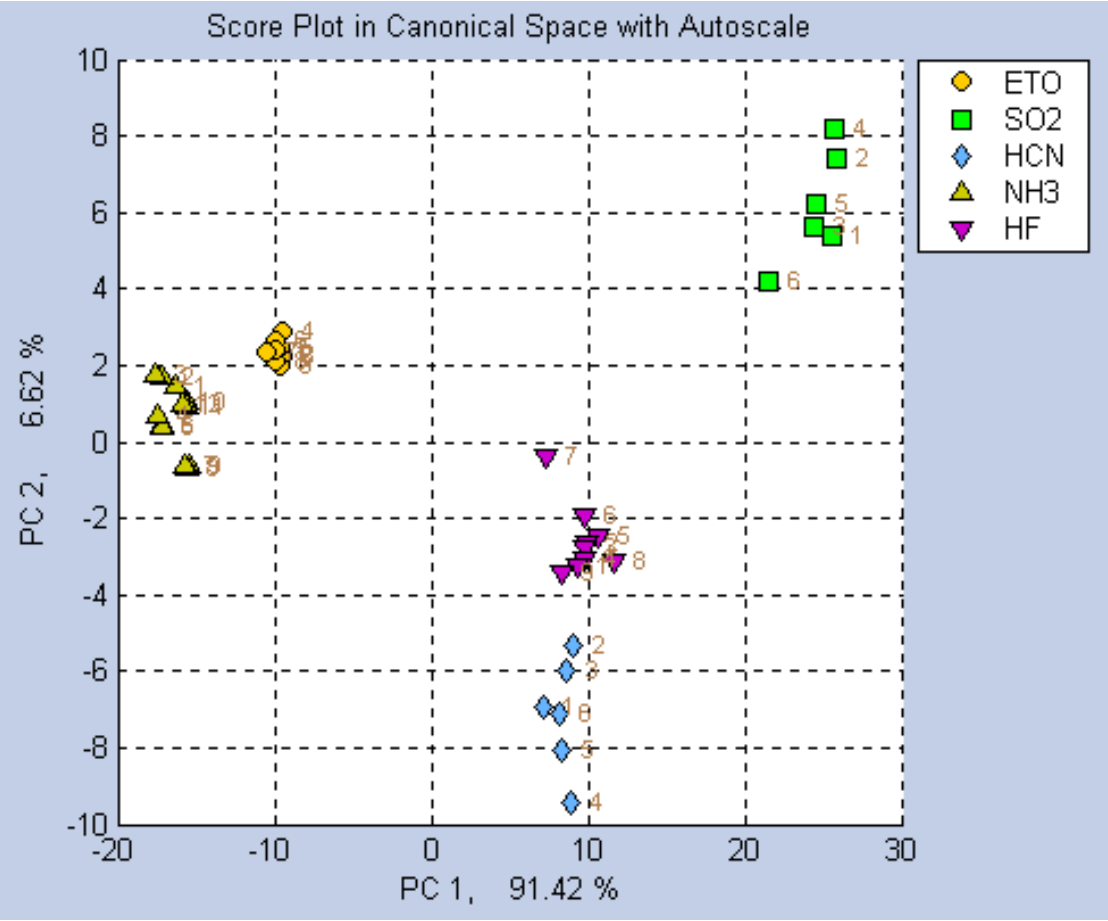
Identification of TICs

TICs

- Hydrogen fluoride
- Hydrogen cyanide
- Ammonia
- Sulfur Dioxide
- Ethylene Oxide

Concentration

- 1/10th IDLH to IDLH



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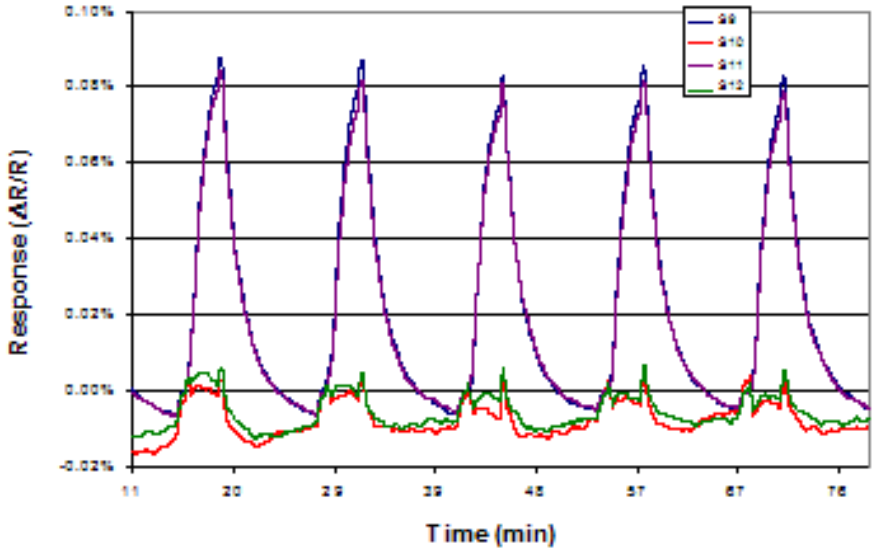
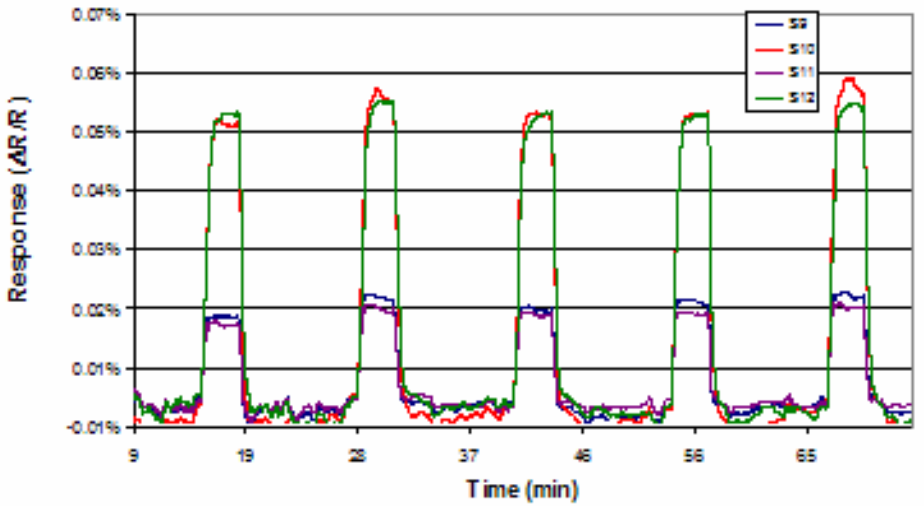
Response Characteristics to G and H agent

Response to Nerve (GA) Agents



Response to Blister (HD) agent



- Polymers are designed to have a reversible response.
- Sensors selected to discriminate between G and H agents
- Response is rapid < 30 s

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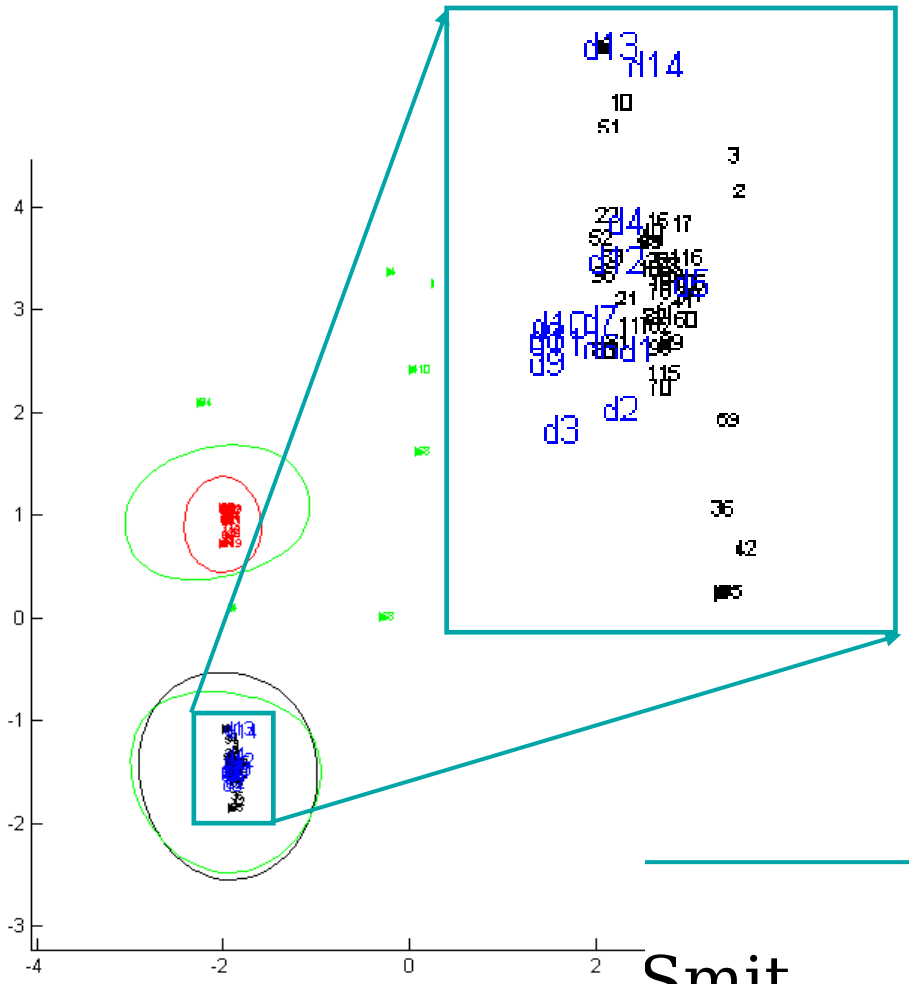
Response Stability over 4 months



- Black = model of DMMP
- Red = model for CEES
- Blue = predictions

- Prediction data for DMMP taken over 127 days
- System exposed to:
  - 0, 25, 50 %RH
  - Toluene, hexane, Chlorox, 409 cleaner, Windex, Floor Stripper, WD40, Orange action
  - All tests at ambient temperature

- 100% correct prediction to date

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Technology Attributes

- Sensitive
  - Broad based chemical sensitivity (ppb-ppm) meets current military spec.
  - Response in seconds
- Stable
  - Reversible, repeatable and robust
- Identification and Discrimination
  - Discrimination between similar compounds is possible
  - Detection of wide range of compounds also possible
  - Combination enables interferent rejection
- Low Cost, Low Power
  - Cheap materials, NanoWatt power

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Conclusions

- Products based upon nanocomposite sensor arrays can be:

  - Sensitive
  - Small
  - Simple to operate
  - Battery powered
  - Light weight
  - Disposable
  - Upgradeable

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Thank you

Contributors:

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Neil Plotkin, Steven Sunshine

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held Point Detector (HSARPA - L

Aircraft Leak Detection (NAVAIR)

Questions?

Saskia Feast, Ph.D.

E: saskiafeast@smithsdetection.com

T: 626-744-1700 ext 276

F: 626-744-1777

Smiths Detection – Pasadena

734 N Vinedo Avenue

Pasadena

CA 91106

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